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ON THE ALLEGED INCREASE OF CANCER.

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The statistical study of cancer as a cause of death, which is the subject of this paper, should not be confused with that of cancer as a disease. Whether the disease is increasing can be answered only by trustworthy morbidity statistics. As no country or city in the world has such statistics, no significant statistical study of cancer as a disease has been or can be written. Hence the present paper is concerned only with the alleged increase of cancer as a cause of death. But at the start it should be conceded that, strong as the argument is for the increase of cancer mortality, that for the increase of cancer morbidity is probably stronger, *i. e.*, the case fatality is probably less than formerly. This would follow from the increasing proportion of operations to cases, in some of which the disease never recurs, in others of which its progress is stayed, affording a longer interval for the occurrence of a death from some other cause. The same conclusion is supported by other improvements in methods of treating cancer, all tending to prolong the patient's life after the onset of the disease and to increase the chance of an intervening death from some other cause.

This paper, however, is concerned only with the question, Is cancer mortality increasing? In nearly all parts of the civilized world the reported mortality is increasing rapidly and this is the basis for the prevalent opinion that the real mortality is increasing. General statements about improvements in the diagnosis of cancer and the increasing proportion of elderly persons especially liable to the disease warrant the opinion that the true increase is less than that shown by the figures, an opinion held by all students of the subject, even those who seem at times to accept the figures at their face value. But these general statements alone do not justify the denial of any increase and leave the problem as one inviting further investigation.

Studies in this field are of two main types, which may be distinguished as intensive and extensive. In the case of an intensive study the figures examined speak for only a limited area, usually a city, and are analyzed in various ways, in order to disentangle their true meaning and to confirm or correct one inference by another. In the case of an extensive study, the figures speak for many different districts, and reliance is placed upon the corroboration derived from similar indications in many or all.

Nearly all studies of the increase of cancer have been made by physicians who have done little work in statistics, but two careful examinations have been made by statists of high repute and are so much more thorough and significant than any of the others that they stand in a class by themselves. One, written by Messrs. King and Newsholme and published in 1893, is a model of an intensive investigation, mainly into evidence derived from the city of Frankfort in Germany.* The other, written by Mr. F. L. Hoffman and published in 1915, is the only example with which I am acquainted of an extensive investigation.† But two other international compilations of vital statistics, including statistics of cancer, have recently been published‡ and a large body of American material for the decade 1900–1909 and the year 1914 has been brought together.§ All these contain uninterpreted figures which can be made to throw no little light upon the alleged increase of cancer mortality.

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* "On the Alleged Increase of Cancer," in Royal Society, *Proceedings*, liv, pp. 209–242. Read May 4, 1893. To be cited henceforth in this article as *King and Newsholme*. Republished in Institute of Actuaries, *Journal*, XXXVI, part II (July, 1901), pp. 120–150.

† *The Mortality from Cancer Throughout the World*, The Prudential Press, Newark, N. J., 1915. To be cited henceforth in this article as *Hoffman*.

‡ *Statistique Internationale du Mouvement de la Population*, in two volumes, Paris, Imprimerie Nationale, 1907 and 1913. To be cited henceforth in this article as *March*. *Statistique Démographique des Grandes Villes du Monde, 1880–1909*, in two parts. (Communications statistiques, Bureau municipal de Statistique d'Amsterdam, nos. 33 and 40.) Amsterdam, Johannes Müller, 1911 and 1912. To be cited henceforth in this article as *Falkenburg*.

§ United States Bureau of the Census, *Mortality Statistics, 1909*, Washington, 1912; and *Mortality from Cancer and Other Malignant Tumors in the Registration Area of the United States, 1914*, Washington, 1916.

In view of this situation, the objects at which I aim are:

1. To review the intensive study of Messrs. King and Newsholme and to present new evidence from Frankfort for the period 1890–1913 by which their argument may be tested.
2. To summarize the results of other intensive studies which have been published since 1893.
3. To make a new extensive study by reviewing and interpreting the large body of evidence recently published in the international and American sources with no fuller interpretation than that found in Mr. Hoffman's volume.

Such a paper seems the more opportune for two reasons: first, because the two most significant studies reach diametrically opposite conclusions, King and Newsholme alleging that "the increase in cancer is only apparent and not real,"* and Hoffman maintaining "that the mortality from cancer is increasing at a more or less alarming rate throughout the entire civilized world"†; and secondly, because little, if any, attention has hitherto been given to the light thrown on this problem by recent international compilations.

The competent statistical study of this question began in 1893 with the paper by Messrs. King and Newsholme. Mr. George King, one author, was Secretary of the Institute of Actuaries and Dr. Arthur Newsholme, the other, was the author of the standard English treatise on vital statistics. This article, written in coöperation by men both adequately equipped in statistics and one equipped in medicine, is probably the most significant statistical discussion of the problem which appeared before 1915 and therefore I shall begin with an examination of its arguments in the light of the additional evidence made available since it was written.

To prove that there is no increase in cancer mortality, all of the apparent increase must be explained by an appeal to other causes. Messrs. King and Newsholme were the first students of the problem who trod this difficult road and they have not found imitators. It is in the choice of a method rather than in the conclusiveness of the results that the main value of their paper lies.

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* *King and Newsholme*, p. 228.

† *Hoffman*, p. 218.

Their main conclusion and the one with which we are primarily concerned was that "the increase in cancer is only apparent and not real." Their argument shows that this statement refers only to cancer mortality and is in no wise inconsistent with an increase of cancer morbidity offset by a diminishing case fatality.

Their subsidiary conclusions supporting this main conclusion were two:

1. A part of the increase in the crude cancer mortality is due to the increasing average age of the population and is eliminated when standardized death rates are computed.

2. In Frankfort-on-the-Main, the only population group in which the annual budget of deaths from cancer at each age and for each sex had long been carefully classified by the organs or parts of the body primarily affected, "the increase in cancer is only apparent and not real and is due to improvement in diagnosis and more careful certification of the causes of death. This is shown by the fact that the whole of the increase has taken place in inaccessible cancer difficult of diagnosis, while accessible cancer easily diagnosed has remained practically stationary."*

This argument was apparently regarded by the authors as decisive and upon it they rested their case.

The second of these two main arguments was supported by two minor arguments, which may first be reviewed in the light of the new evidence.

1. The increase of cancer mortality between 1860 and 1891 among men insured in the Scottish Widows' Fund Life Assurance Society, the only group of insured persons for which the requisite information could be obtained, was much less rapid than its increase in the general population of Scotland. This difference was explained by supposing that, when the figures began, the diagnosis of cancer among insured persons was more accurate and among them, in consequence, the effect of improvement of diagnosis during the thirty years was less than in the general population.

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* *King and Newsholme*, p. 228.

2. Cancer mortality was lower but increased faster among men than among women. This was ascribed to the greater proportion of cases of inaccessible cancer among men, the greater obstacles to accurate diagnosis in such cases, and the more rapid improvement in the diagnosis of inaccessible cancer.

Their argument from insurance experience is illustrated by the following figures compiled from those in their article.

DEATH RATE FROM CANCER PER 100,000 MALES AT LEAST TWENTY-FIVE YEARS OF AGE, DISTRIBUTED IN AGE GROUPS AS IN ENGLISH LIFE TABLE NO. 3.

Period.	Insured in Scottish Widows' Fund Life Assurance Society.	In Total Population of Scotland.
1860–1866	60	70
1867–1873	83	82
1874–1880	75	101
1881–1887	85	115

The increase of the death rate among the general male population was 45 per 100,000, or 64 per cent., that among the insured males was 25 per 100,000, or 42 per cent. Mr. Hoffman quotes some additional evidence furnished by the medical officer of the same Society,* the figures of which, it will be noted, do not agree entirely with those published by Messrs. King and Newsholme. I learn from the actuary of one of the largest American insurance companies that probably no evidence on this point has been published by any American company. But even if it were buttressed by much additional material, I cannot attach great weight to this argument, because of the uncertain influence of selection in any class of insured persons. During the thirty years covered by the experience of the Scottish insurance company, for example, it may have extended its business among classes somewhat less subject to cancer than its earlier policy holders or the protective influence of the company's medical selection may have diminished.

The second argument advanced by Messrs. King and Newsholme is based upon the lower rate and more rapid increase in the cancer mortality of men. Among males cancer usually attacks an inaccessible organ or part of the body and for that reason is difficult to diagnose correctly even at the time of death, a difficulty which has decreased with the improvements of modern medicine and surgery. Thus, accepting as correct their classification of deaths from cancer in Frankfort into the two groups of accessible and inaccessible, 97 per cent. of the male deaths and only 63 per cent. of the female deaths ascribed to such cancers occurred where the seat of the disease was inaccessible.* Their argument is illustrated by the following figures computed from those in their paper.

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* *Hoffman*, pp. 84, ff.

DEATH RATE FROM CANCER PER 100,000 PERSONS OF SEX INDICATED AND AT LEAST TWENTY-FIVE YEARS OF AGE DISTRIBUTED IN AGE GROUPS AS IN ENGLISH LIFE TABLE NO. 3.

Country.	1860.	1890.	Increase.	
			Amount.	Per Cent.
MALES.				
England	59	145	86	146
Scotland	67	174	107	160
Ireland	59	92	33	56
FEMALES.				
England	119	210	91	77
Scotland	116	220	104	90
Ireland	72	111	39	54

The foregoing figures show that in all these divisions the female rates at both dates were much higher, that in England and Scotland the actual increase for the two sexes is about the same and the relative increase for men much greater, but that in Ireland the same facts do not appear. What do the recently published compilations show about the comparative increase of cancer in the two sexes? *Hoffman* alone gives death rates by sex. These he gives for each of the New England states, for Massachusetts since 1856, for Rhode Island since 1871, for Connecticut since 1879, for New Hampshire since 1887, for Maine since 1892, and for Vermont,

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* The data involved will be found in the Appendix, Table VIII.

1871–1896. In 2 of these states the absolute increase and in 4 the relative increase of cancer mortality was greater among men than among women. A summary of his figures for the first 5 states since 1896 by sex yields the following results:*

Period.	Death Rate per 100,000 Population.		Increase.				Ratio of Male Rate to Female (=100).
			Amount.		Rate.		
	Male.	Female.	Male.	Female.	Male.	Female.	
1896–1900	46.2	90.3					51.2
1901–1905	53.6	100.9	7.4	10.6	16.0	11.7	53.1
1906–1910	61.5	110.9	7.9	10.0	14.7	9.9	55.5

These figures show that the rate of increase in cancer mortality among men has been somewhat more rapid than among women and that during the period the ratio of male mortality to female increased 4.3 per cent.

For the Federal registration area as constituted in 1900† the cancer death rates by sex were:

Year.	Death Rate per 100,000 Population.		Increase.				Ratio of Male Rate to Female (=100).
			Amount.		Rate.		
	Male.	Female.	Male.	Female.	Male.	Female.	
1900	47.0	80.7					58.2
1915	72.3	111.9	25.3	31.2	53.8	38.7	64.6

indicating that among men the increase was less, but the rate of increase greater, than among women. The ratio of male mortality to female increased 6.4 per cent. in fifteen years.

Among the 26 American cities for which Mr. Hoffman gives death rates by sex there are 10 in which the absolute increase and 19 in which the relative increase of the cancer mortality

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* For the figures on which these rates are based see Appendix, Table I.

† Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, District of Columbia, Michigan, and Indiana. See Appendix, Table II. For our problem the figures of "the registration area" are without value, because of that area's rapid expansion since 1900.

In this case the tendency of the male rate to overtake the female is more clearly marked, for the amount as well as the rate of increase is greater among the men. The ratio of male mortality to female increased 6.4 per cent. As each rate in the table is based upon more than 100,000 deaths from cancer, the steady decrease in the difference between the sexes is of more importance for the argument than that shown in the preceding tables.

Among the 33 foreign cities for which Mr. Hoffman gives the mortality by sex there are 24 in which the absolute increase and 26 in which the relative increase of the cancer death rate is greater among men. The figures by sex since 1896, given for 13 foreign cities separately and the cities of Denmark collectively, yield the following summary.*

Period.	Death Rate per 100,000 Population.		Increase.				Ratio of Male Rate to Female (=100).
			Amount.		Rate.		
	Male.	Female.	Male.	Female.	Male.	Female.	
1896–1900	80.4	107.6					74.7
1901–1905	90.3	115.0	9.9	7.4	12.3	6.9	78.5
1906–1910	99.4	120.1	9.1	5.1	10.1	4.4	82.8

The ratio of male mortality to female has increased 8.1 per cent.

All the new evidence supports the conclusion of Messrs. King and Newsholme that the death rates from cancer in the two sexes are approaching equality as a result of the more rapid increase among men.

Having reviewed the new evidence in these two subsidiary arguments, we turn now to the second of the main arguments advanced by Messrs. King and Newsholme, an argument supported by this difference between the cancer mortality of the two sexes. This alleges that the increase in cancer mortality is confined to mortality from inaccessible cancer. Their evidence on this point is derived from the figures of Frankfort-on-the-Main. They seem to have accepted the Frankfort returns without any attempt to investigate the accuracy of the classification according to the part of the body affected by a study on the ground both of the original material and of the methods of treating it, a precaution which might well have been taken when so much depended on its accuracy. The able statists of Frankfort probably did not attach to this classification as much weight as the English interpreters. Certainly they abandoned it in 1891 and the Frankfort director, in a letter to me on the subject, volunteers the statement that in the opinion of German statists the diagnosis of cancer is not entirely trustworthy and that physicians out of regard for the family sometimes certify a death really due to cancer to be due to some less distasteful cause, like tumor.

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* Appendix, Table V.

Notwithstanding these reasons for giving less weight than our authors do to the Frankfort figures, it seemed wise to bring them down to date, if possible,—the more so, because in the 24 years since their article was published little new evidence has appeared based on a classification of deaths from cancer as located in accessible or inaccessible parts of the body. It was found, as mentioned above, that the Frankfort statistical office had abandoned the classification after 1891; consequently it was necessary to make a special tabulation of the figures since that date. In order to insure comparability between the later and earlier figures, the returns for 1888 and 1889, which Messrs. King and Newsholme had compiled, were recompiled and their treatment of a few doubtful groups followed.

Some writers have objected to the classification of deaths from cancer according as the seat of the disease was accessible

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* The needed sum was given by Dr. James Douglas at the suggestion of Prof. James Ewing, at whose request my paper was begun and who has aided me throughout its progress. Without his encouragement I should hardly have ventured so far into the field of medical statistics. I am greatly indebted to Director Busch of the Frankfort statistical office, who arranged to have his subordinates compile the data, and to Prof. R. M. Woodbury, then a travelling Fellow of Cornell University pursuing studies in economics and statistics at the University of Berlin, who went twice from there to Frankfort to explain exactly what was wanted and to review the results. His later services in Ithaca were also of much help in this part of the problem. The manuscript tables obtained from Frankfort have been deposited with the Library of the Surgeon-General's Office in Washington, where they may be examined by any persons desiring to test my inferences from them. The figures for 1860 to 1889, inclusive, are in *King and Newsholme;* those for 1890 are in the *Stat. Mittheilungen* of Frankfort for that year. But some of the certificates for 1890 and 1896 are now lacking and hence the returns for those two years have been disregarded. In Appendix, Tables VI–X, will be found all of Messrs. King and Newsholme's Frankfort material, each table supplemented by additional figures so as to add five new periods between 1888 and 1913.

or inaccessible, alleging either that a third class of intermediate cases should have been recognized or that certain organs or parts considered by Messrs. King and Newsholme as accessible should have been put in the inaccessible class or *vice versa.* In reply to the first objection, it is clear that the introduction of a third class of intermediate cases would obscure the argument. For our purposes a dual classification with a few border line groups thrown to one side or the other according to where most of the cases in the group belong is far better than the alternative triple classification. Whether their classification could have been improved is a question of technical medicine into which fortunately there is no need to go. My present object being merely to bring their material down to date, I would have to follow their classification, even if I knew, as I do not, that it had serious defects. But, in passing, I may mention that their decisions have found remarkable confirmation in the statistics of the Census Bureau's special bulletin on *Mortality from Cancer in 1914*, mentioned on p. 702, footnote §. Thousands of American doctors were asked to state, in connection with each cancer death certificate which they had filled out, whether the diagnosis was based on clinical findings, or confirmed by surgical operation or autopsy. With the help of their answers, the cancer deaths were classified under the captions "Diagnosis reasonably certain," and "Diagnosis uncertain." To this point I shall recur later (pp. 749, ff).

The new tables for Frankfort extend the original ones so that they embrace the fifty-four years, 1860–1913, instead of only the thirty years, 1860–1889, and nine thousand deaths instead of three thousand.* The final result is shown in the following table:

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* Compare Appendix, Tables VI–X.

FRANKFORT. ANNUAL DEATHS FROM CANCER IN 1,000,000 LIVING, AT LEAST TWENTY-FIVE YEARS OF AGE. POPULATION DISTRIBUTED IN AGE GROUPS ACCORDING TO ENGLISH LIFE TABLE NO. 3.—PERSONS.(a)

Period.	Accessible.	Inaccessible.	Position Undefined.	Total.
		MALES.		
1860-1866	126	1,118	359	1,603
1867-1873	88	1,421	137	1,646
1874-1880	14	1,913	363	2,290
1881-1887	35	1,865	305	2,205
1888-1893(b)	91	2,289	171	2,551
1894-1899(c)	66	2,489	104	2,659
1900-1904	51	2,742	118	2,911
1905-1909	68	2,791	119	2,981
1910-1913	119	2,522	130	2,771
		FEMALES.		
1860-1866	1,081	1,323	293	2,697
1867-1873	1,214	1,540	254	3,008
1874-1880	1,220	1,588	131	2,939
1881-1887	981	1,820	272	3,073
1888-1893(b)	1,275	1,959	174	3,408
1894-1899(c)	903	1,936	122	2,961
1900-1904	914	2,013	115	3,042
1905-1909	925	2,311	180	3,416
1910-1913	913	2,057	152	3,122

(a) Figures from 1860 to 1887, inclusive, derived from *King and Newsholme*, Table XVI. Figures for later years derived from manuscript tables from the Frankfort Statistical Office.
(b) Omitting the year 1890, for which the figures were not available.
(c) Omitting the year 1896, for which the figures were not available.

The general meaning of the table can be read more easily and clearly in the form of a diagram.* For the sake of simplicity the categories of "position undefined" for each sex and the total rates for each sex have been omitted and the diagram depicts, therefore, the conditions stated in the first two columns of the preceding table.

Both table and diagram show, each in its own way, that there has been no significant change in the small mortality from accessible cancer of men and there have been irregular changes followed by a remarkable uniformity in the mortality from accessible cancer of women. Almost all the increase occurred in the mortality from inaccessible cancer, although by a surprising exception that mortality in each sex decreased between the last two periods, while the mortality of men from

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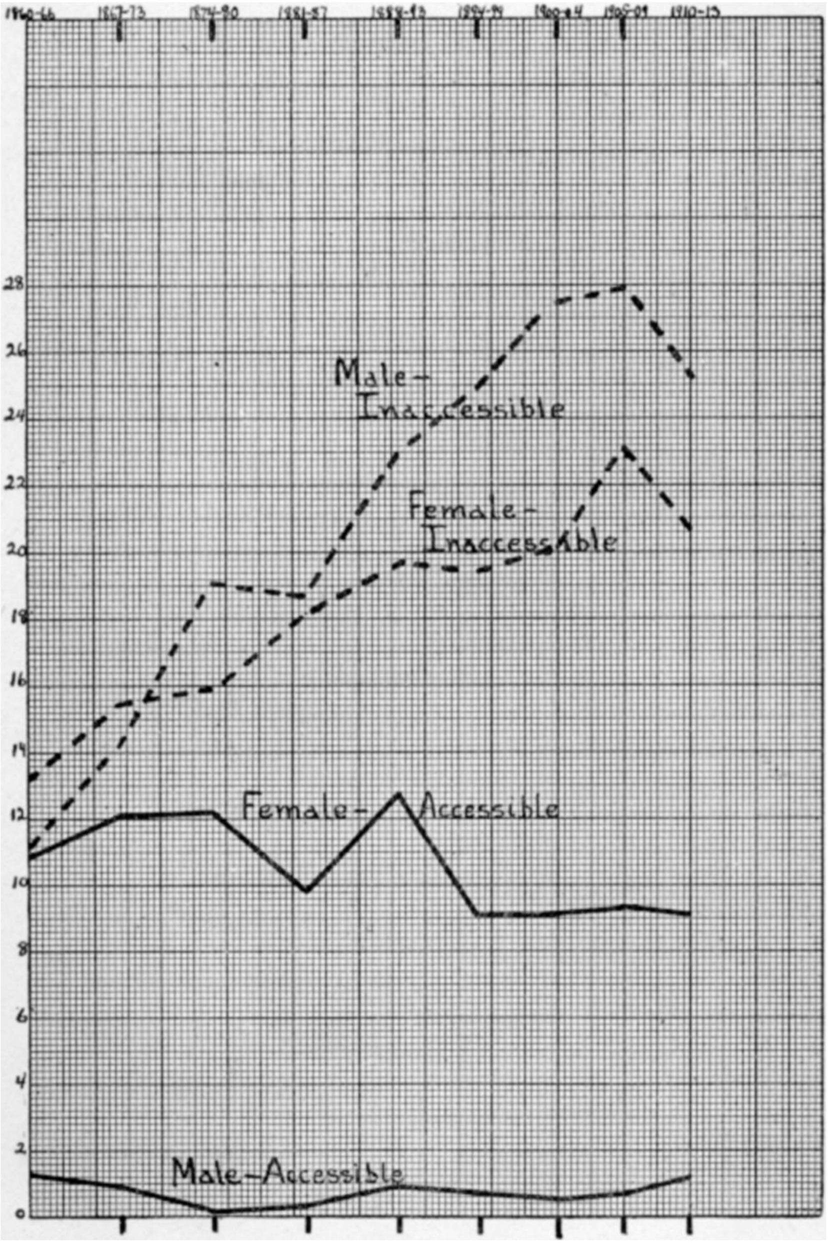
* See p. 713.

DIAGRAM I. DEATH RATES FROM CANCER, ACESSIBLE AND INACCESSIBLE, FRANKFORT-A-M.: 1860–1913.



accessible cancer increased. The argument of Messrs. King and Newsholme from the Frankfort figures is thus materially strengthened.

To this argument several objections have been made.

1. "It is quite doubtful whether all uterine or even vaginal cancer can be accurately diagnosed as such without an exploratory operation or a microscopical examination of the diseased parts."* The evidence in the Census Bureau's recent bulletin on cancer, to which reference has already been made (p. 711) leads to a different conclusion.

2. "A fair proportion of deaths from cancer are those of the skin, other parts of the mouth than the tongue, and other external parts of the body"† and these should have been classed as accessible. The objection overlooks the fact that these classes are not distinguished in the printed sources used by Messrs. King and Newsholme.

3. The authors "for reasons unknown" have not reëxamined the Frankfort data since 1893.‡ This overlooks the fact, already mentioned, that the method of publishing the Frankfort figures was radically changed at about the time the original article was published and serious difficulties put in the way of a reëxamination.

4. It is not clear whether correction was made for deaths from cancer among inmates of Frankfort hospitals who were non-residents of that city.§ Careful inquiry at the Frankfort registration office, supplemented by inspection of the manuscript returns, showed that they were not systematically excluded, but that the smallness of their number made them unimportant.

5. The classification of deaths in Frankfort "fails to conform to modern requirements in that it is not in accordance with the international classification of causes of death."|| A classification is to be judged with reference to the object it was designed to serve and the character of the material to be classified. There is little reason to suppose that the international classi-

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* *Hoffman*, p. 31.

† *Ibid.*

‡ *Ibid.*

§ *Ibid.*, footnote.

|| *Hoffman*, p. 33.

fication is better adapted to the specific study of cancer death rates than another which may have had that object in view and certainly has been found valuable for it.

6. The results do not agree with those derived from the Frankfort data for 1906–1913 given in the official reports of the Frankfort Medical Society.* The latter are in conflict with those for the same years which I have derived from the official records of the Frankfort statistical bureau and already presented, and the differences appear irreconcilable. The figures of the Medical Society make no attempt at a classification into accessible and inaccessible and in consequence have little bearing upon the argument.

7. The standardized death rates from cancer in Frankfort, 1860–1889, by five periods of years show irregular changes, perhaps due to paucity of numbers, but they cannot be interpreted as affording no evidence of increase in the rates for accessible cases among women.† To this objection the supplementary figures already presented afford perhaps a sufficient reply.

These objections to the argument of Messrs. King and Newsholme do little to weaken its probative value. An objection of greater weight than these lies against their reliance upon standardized rates and will have to be considered later. In face of all the objections we can hardly accept their conclusion in the emphatic way in which it is stated. Neither the original argument nor my amplification of it, nearly doubling the period of observation and more than trebling the number of cases, can be held to justify completely their statement that "the increase in cancer is only apparent and not real and is due to improvement in diagnosis and more careful certification of the causes of death." The great merits of their paper lie in exemplifying the correct method of attacking the problem and showing beyond question that a measurable part of the increase in the mortality from cancer is due to a better diagnosis of the causes of death and another measurable part to the increasing proportion of persons who live on to ages when cancer is prevalent.

Let us now examine the first of their two main arguments, namely, that part of the increase is due to changes in the age and sex composition of the population and can be measured by the use of standardized death rates. No one will question that the increasing proportion of elderly persons in the population accounts for part of the increase in cancer mortality. But that this part can be measured by the help of standardized rates has been somewhat uncritically taken for granted in the United States and England. Various earlier writers had pointed out that cancer is preëminently a disease of adult and elderly life and that the proportion of the population at any moment living at ages when cancer is frequent is increasing with the lengthening of human life. But it was reserved for Messrs. King and Newsholme to put the argument into the necessary quantitative form. In computing standard death rates, they chose for the population a standard million based on English Life Table No. 3, Persons. To this they applied the cancer death rates for each sex and age group at each of two periods and compared the results. In such a computation the increase or decrease in the computed deaths is supposed to show by how much the cancer mortality would have increased or decreased, if there had been no change in the sex and age composition of the population but such changes as did occur in death rates.

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* *Hoffman*, p. 31.

† Greenwood and Wood, "On Changes in the Recorded Mortality from Cancer and their Possible Interpretation," in *Proceedings of the Royal Society of Medicine*, VII, no. 1, pp. 119–70.

This method of using standardized rates has long been followed in England, has recently been adopted in the United States, and is regarded by Messrs. King and Newsholme as a prime requisite to sound work in dealing with the present problem. They say: "In order to be useful, the materials . . . must be presented in such form that, at any rate for several intervals of years, the deaths from cancer and the population may be grouped according to sex and age" ; and it was because these conditions were satisfied nowhere but in the Frankfort statistics and those of the Scottish Widows Fund Life Assurance Society that our authors relied so heavily upon that material. Their principle is a veritable bed of Procrustes. Its acceptance excluded at one stroke probably all other cancer statistics than those mentioned, and, if it is sound, the significant material is still so meager as to make an

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*P. 212.

extensive study even now quite out of the question. Accordingly the principle should not be accepted without a more careful scrutiny than it has hitherto received. The method assumes that a standard population is needed but that it is a matter of indifference what standard is adopted. Thus Messrs. King and Newsholme say: "It is not of importance what standard is selected, because, all the observations being treated alike, the comparisons instituted between them will be entirely trustworthy."*

It is desirable to put this assertion to the test. The standards most likely to be in the mind of Englishmen writing in 1893 were the English Life Table No. 3 and the population of England in 1881, the date of the latest available census. A comparison of these two standards is made in Table XI of the Appendix and is expressed to the eye through the diagram on page 719.

The diagram shows clearly what the figures confirm and make precise, that the proportions actually living at the various ages in England in 1881 were very different from those shown by a life table. The life table assumes a population exempt from the disturbing factors of emigration and immigration and also from the distortion engendered by a rapidly increasing population, which swells inordinately the contingents belonging to the early years of life. Cancer is a cause of death almost unknown in infancy and childhood but common in adult and elderly years. Hence the standardized death rate from cancer obtained by using a standard in which adults and elderly persons are numerous must be much above the rate obtained by using a standard in which they are relatively few. For example, the standardized cancer mortality of Frankfort, 1860–1866, was 107 per 100,000, if the standard used is the English Life Table population, but only 70, or about two thirds as high, if the standard is the population of England and Wales in 1881.† To this objection it might be replied that the information needed is not the standardized rate in any single period but the increase between two periods and that the increase, absolute or relative, might be the same even though the rates compared were widely different. But the answer is unsatisfactory for two reasons: first, if the absolute increases were the same, the relative or proportional increases could not be; and, secondly, as the increase in the cancer death rate as well as its amount varies greatly with age, the chances against the agreement of two increases reached by using two such divergent standards are indefinitely great. In the case in hand, if the life table population is the standard, the increase in the standardized death rate of Frankfort is from 107 per 100,000 in 1860–1866 to 167 per 100,000 in 1888–1889, which is 60 per 100,000, or 57 per cent.; but if the population of England in 1881 be the standard, the increase is from 70 in 1860–1866 to 107 in 1888–1889, which is 37 per 100,000, or 53 per cent.*

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* Pp. 211–12.

† See Appendix, Table XII.

From this argument it might be inferred that the method of standardized death rates, if not generally invalid, is at least inapplicable to the present problem. But that would be going too far. In most civilized countries the average age of the population is slowly increasing, due in part to the fall in the death rate, especially in early years, and in part to the fall in the birth rate. For example, in the United States the median age of the population increased by 7.3 years between 1820 and 1910,† or about four fifths of a year in each decade; and similar, though less rapid, changes are probably occurring in many other countries. Wherever this change is in progress some part of the increase in cancer mortality is due to it. It is theoretically possible that the whole might be so explained. Under these circumstances either some estimate of the part due to that cause must be reached or our problem abandoned on the threshold. An escape from the dilemma may be found along the following path if the requisite data are available.

To the population of a given sex and age at the beginning of a period the corresponding cancer death rates at the end of the period are applied, the sum of the computed deaths being the number which would have occurred, had the composition of the population remained unchanged. From this sum a "corrected" death rate and the increase during the period due only to the changes in reported cancer mortality may be

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* Appendix, Table XIII.

† United States Bureau of the Census, *Thirteenth Census*, vol. I, p. 309.

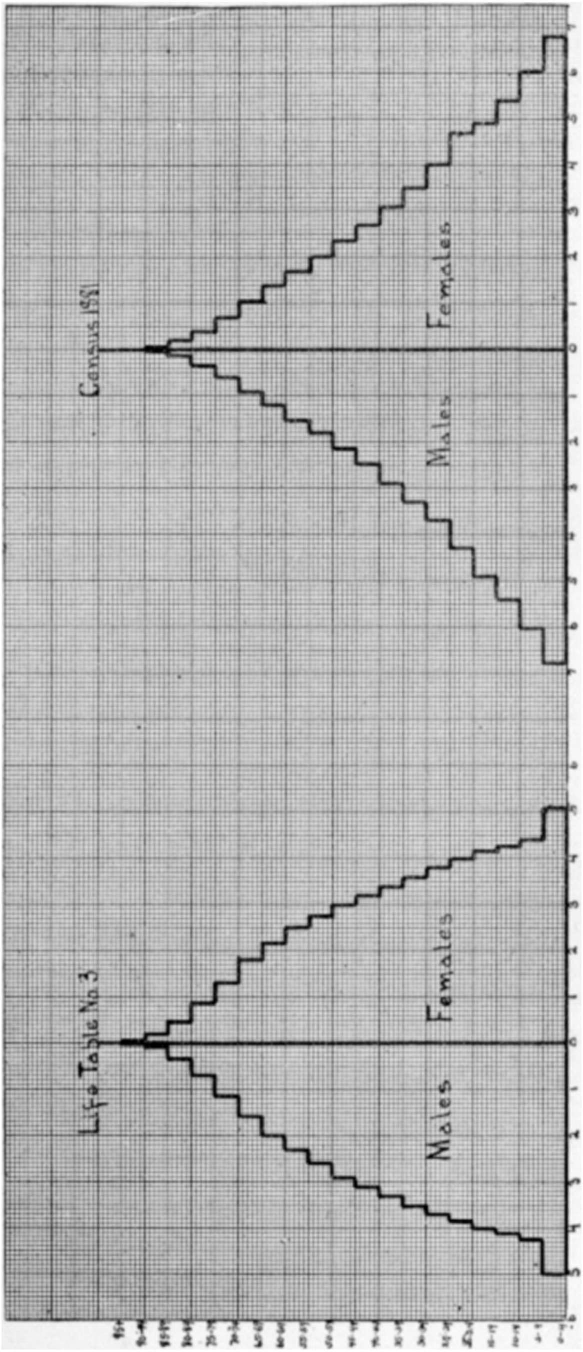

DIAGRAM II. STANDARD MILLION, ENGLISH LIFE TABLE No. 3 AND ENGLAND AND WALES CENSUS OF 1891 derived. A comparison between this increase and that in the crude rates shows how much, if any, of the latter is due to a change in the sex and age composition of the population. Such computations have been made for this study in a few cases chosen at random.

a. The American registration states of 1900* include all states for which the death rate from cancer both in 1900 and 1910 is known. The crude death rate from cancer was 63.9 per 100,000 in 1900 and 83.0 in 1910, an increase of 19.1 per 100,000, or 29.9 per cent.† The standardized death rate in 1910, accepting the distribution of population in the same states in 1900 as the standard, was 81.3, instead of 83.0, an increase over 1900 of 17.4 per 100,000, or 27.2 per cent.‡ As 27.2 is 91 per cent., or about nine tenths, of 29.9, it is evident that about one tenth of the increase in the crude rate was due to the decennial change in the sex and age composition of the population.

b. In England and Wales the crude death rate from cancer was 84.3 per 100,000 in 1901 and 99.3 in 1911, an increase of 15.0 per 100,000, or 17.8 per cent.§ The standardized death rate in 1911, accepting the distribution of population in England and Wales in 1901 as the standard, was 91.5, an increase over 1901 of 7.3 per 100,000, or 8.7 per cent.‖ As 8.7 is less than half of 17.8, it is evident that more than one half of the increase in the crude rate between 1901 and 1911 was due to the decennial change in the sex and age composition of the population.

c. In England and Wales the crude death rate from cancer was 58.9 per 100,000 in 1881–1890 and 75.8 in 1891–1900, a decennial increase of 16.9, or 28.7 per cent.¶ The standardized death rate, 1891–1900, accepting the distribution of population in England and Wales in the decade 1881–1890 as the standard, was 74.8 per 100,000, an increase of 15.9 per 100,000, or 27.0 per cent. As 27.0 is about fifteen sixteenths of 28.7, it is evident that about one sixteenth of the increase in England's crude death rate from cancer in the decade 1891–1900 as compared with the decade 1881–1890 was due to the decimial change in the composition of the population.

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* See p. 707, footnote †.

† See Appendix, Table XIV.

‡ See Appendix, Table XV. The method here used differs from that of the Bureau of the Census (*Mortality Statistics, 1911*, p. 33) in two respects: first, the standard population is not that of England and Wales in 1901, but that of the American registration states in 1900, and, secondly, the crude death rates used are those of the calendar years 1900 and 1910 instead of 1901 and 1911.

§ See *Hoffman*, p. 596, Table 6.

‖ See Appendix, Table XVI.

¶ Registrar-General of England and Wales, *Supp. to 55th Ann. Rep.*, pt. I, p. xxviii; *Supp. to 65th Ann. Rep.*, pt. I, p. xcix.

d. In New York City the crude death rate from cancer was 65.5 per 100,000 in 1900 and 78.0 in 1910, an increase of 12.5 per 100,000, or 19.1 per cent.† The standardized death rate in 1910, accepting the distribution of population in New York City in 1900 as the standard, was 76.6, an increase of 11.1 per 100,000, or 16.9 per cent.‡ As 16.9 is about eight ninths of 19.1, it is evident that about one ninth of the increase in the crude death rate of New York City between 1900 and 1910 was due to the change in the composition of the population.

e. In London the crude death rate from cancer was 93.7 per 100,000 in 1901 and 107.2 in 1911, an increase of 13.5 per 100,000, or 14.4 per cent.§ The standardized death rate in 1911, accepting the distribution of population in London in 1901 as the standard, was 95.5, an increase of 1.6 per 100,000, or 1.7 per cent. As 1.7 is less than one eighth of 14.4, it is evident that more than seventh eighths of the increase in the crude death rate of London between 1901 and 1911 was due to the change in the composition of the population between those dates.

The general result of these calculations is to show that a considerable part of the increase in the crude death rate from cancer, a part ranging in these five cases from 5 to 88 per cent. and averaging about one third, is due to changes in the sex and age composition of the population. From the evidence I conclude that on the average not less than one tenth of the apparent increase may be thus explained and that, wherever the birth rate as well as the death rate has been falling over a period of years and in consequence the proportion of adult and aged persons in the population has been rapidly rising, there the change in the sex and age composition of the population may explain a much larger part of the increase in the crude death rate from cancer.

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* See Appendix, Table XVII.

† See United States Census Bureau, *Mortality Statistics, 1909*, p. 156, and *1910*, p. 103.

‡ See Appendix, Table XVIII.

§ *Hoffman*, p. 605, Table XVI.

‖ See Appendix, Table XIX.

¶ I select this fraction somewhat arbitrarily because it comes near the result for the American registration states and the smaller of the two results for England. Results for a great country are likely to be nearer the average than those for any city, however populous.

The article of Messrs. King and Newsholme, then, is faulty at a point where it has not hitherto been criticized, its unhesitating reliance upon standardized death rates of the usual type and its rejection of all material which does not lend itself to that method. It is valuable because of its emphasis upon the influence of improved diagnosis as a factor and even more significant because it pointed out that other causes competent to produce the result must be detected and measured by whoever denies that any part of the apparent increase of cancer is real.

Since their article was published a few other intensive studies have appeared, although none, I believe, indicates so firm a mastery of the method to be pursued and none carries out so thoroughly the distinction between accessible and inaccessible cases. The results of these may now be briefly summarized.

Massachusetts (1850–1895). In his first study Dr. Whitney concluded that "The increase is probably due to better diagnosis and registration and until the ratio of deaths over 30 years [sc. to all deaths at that period of life] has reached 8 to 9 per cent., which is shown by autopsies to be the true rate for cancer, it is not justifiable to speak of the increase as inherent in the disease itself."* But in a later article he admitted the existence of "a steady increase in the deaths [sc. death rates?] from cancer which cannot be explained by improved registration and more careful diagnosis."†

District of Columbia (1881-1900). Dr. Smith accepts the views of Messrs. King and Newsholme and believes that the evidence does not demonstrate any increase in the true death rate from cancer.‡

Providence, R. I. (1856–1905). Dr. Chapin thinks it probable, "that there has been no real increase in those forms of cancer which are visible or the diagnosis of which is easily made," namely, cancer of the breast and cancer of the uterus; and that "the apparent great increase in the mortality from cancer is due to improved diagnosis and changes in the sex and age distribution of the population."*

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* Wm. F. Whitney, "Alleged Increase of Cancer in Massachusetts," Shattuck Lecture before Massachusetts Medical Society, June 11, 1901, p. 20.

† "Statistics of Cancer in Massachusetts," in *Boston Med. and Surg. Journ.*, *CLXII* (May 19, 1910), p. 673.

‡ C. A. Smith, "District of Columbia Cancer Record," in *Am. Med.*, *III* (1902), pp. 916–19.

Breslau (1876–1900). Dr. Frief showed that the death rate from cancer of the breast and uterus had been stationary and the whole increase was due to an increase in cancer of the abdomen. He concluded that, when the needed precautions had been taken and the needed corrections made, no regular and decided increase in the death rate from cancer was demonstrable.†

Utrecht (1872–1902). Dr. Astro showed that the death rate from those forms of cancer which were easily diagnosed fell to three fourths of the initial rate, while the death rate from cancer of other forms more than doubled.‡

Amsterdam (1862–1902). Dr. Van Konijnenburg concluded that it was impossible to decide with confidence how much of the increase in the recorded death rate from cancer was due to a real increase and how much to improved diagnosis.§

Paris (1886–1905). Dr. Bertillon showed that, during these 20 years, the death rate from cancer of the mouth, breast, and female generative organs hardly increased at all, but that from cancer of the stomach increased rapidly and that from cancer of the intestines more rapidly. In other words, the increase in the recorded death rate was practically confined to cases of inaccessible cancer.||

Netherlands (1867–1909). Director Methorst was unable to determine whether the increase of cancer was due to a greater prevalence of the disease or to greater accuracy in its diagnosis, the latter influence certainly accounting for a part of the increase.¶

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* *City Registrar's Report, 1905*, pp. 89–93.

† *Klinisches Jahrbuch, XII* (1904), p. 154.

‡ Quoted in Van Konijnenburg, *Mortalité par Cancer à Amsterdam, 1862–1902*, pp. 14 and 11. Müller, Amsterdam, 1911.

§ *Ibid.*

|| *Annuaire Statistique de la Ville de Paris,* XXV (1904), p. 202.

¶ International Statistical Institute, *Bulletin*, XIX, pt. III, pp. 310–312.

England and Wales. Dr. Stevenson in a careful and illuminating study of English cancer death rates, published in 1913, reached no conclusion upon the main question. In the following year Major Greenwood, Jr., and Frances Wood, discussing Dr. Stevenson's evidence and arguments, reached the general conclusion "that there is some truth in the popular opinion that the real incidence of cancer has increased."†

Both of these English papers and no little current discussion seem to favor the view that the general question with which this article is concerned, Is the mortality from cancer increasing? can best be attacked by breaking it up into a series of subordinate questions like, Is cancer of the breast increasing? and answering the former only by finding the resultant of various and probably conflicting currents of change in cancer of various parts or organs. I cannot but feel that this is postponing attack upon the simpler statistical problem until a series of more difficult ones are solved. In other words, however unsatisfactory the present discrimination and reporting of cancer as a cause of death may be, and I believe them, as a rule, to be very unsatisfactory, they are probably much more accurate and trustworthy than the reporting of the organ or part of the body primarily affected by the disease.

These are all the significant intensive studies of the increase of cancer which have come to my attention.

An incidental result of rejecting as I do the method of standardized rates as the only or main method, is that it opens the door for that extensive study of the material in the recent international compilations to which we now turn our attention.

When inquiring how far, if at all, improvements in the diagnosis of cancer account for the increase in reported cancer mortality, we should recall the four ways in which statements of the cause on certificates of death may be obtained:‡ (1) from a medical examiner, authorized and required to perform an autopsy whenever necessary for confirming the diagnosis; (2) from an officer required to examine the body and consult with the attending physician but not authorized to perform an autopsy; (3) from the attending physician, midwife, next of kin, coroner, or person best informed; (4) from whoever reports the death to the registration officer.

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* *74th Annual Report of the Registrar-General,* for 1911.

† Royal Society of Medicine, *Proceedings,* VII, no. 1, pp. 119-170.

‡ *Cf.* von Mayr, *Statistik und Gesellschaftslehre,* II, §75 (Die Todesursachen), pp. 309-329; and Prinzing, *Medizinisches Statistik,* pt. 3, chap. 6. (Die Todesursachen), pp. 318-406.

When the figures are to be used for such a purpose as ours the fourth method is valueless. The first method would be most accurate but is nowhere in use at present. As the frequency of autopsies is connected with the increasing number and size of cities and with the development of hospital facilities,* this method may come into general use in the remote future. At present accuracy in the statement of the cause of death may be expected only for cities and countries in which the cause is regularly certified by a medical examiner or attending physician and even in such cases it depends upon the ability of the physician to diagnose and his willingness to certify cancer as a cause.

Cancer is seldom reported by a layman as a cause of death. Hence the proportion of deaths ascribed to that disease usually depends upon the proportion of physicians to population and more especially upon the proportion of deaths reported by physicians to all deaths. Have these proportions been increasing?

The following figures‡ show that the proportion of physicians in Germany has increased:

Date.	Number of Physicians to 100,000 Population in Germany.
1876	32
1887	33
1898	44
1904	54

That a similar change was in progress in England and Wales down to 1901 appears from the following figures:

Date.	Number of Physicians to 100,000 Population in England and Wales.
1881	58
1891	66
1901	70
1911	65

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* In 15 large cities of Switzerland 26 per cent. of the deaths in 1900 and in the city of Basel 34 per cent. of the deaths in 1902 were followed by autopsies. Of the autopsies in Basel 86 per cent. occurred in hospitals and only 14 per cent. outside. *Cf.* Prinzing, *op. cit.*, p. 320.

† *Cf.* pp. 740, *f.*

‡ Prinzing, *op. cit.*, p. 541.

There is no trend in the United States similar to that in England and Germany.

Date.	Number of Physicians to 100,000 Population in the United States.
1880	171
1890	166
1900	174
1910	164

The proportion of physicians to population in this country is about three times as great as in Germany and more than twice as great as in England, but is not increasing. Probably much of the difference is due to differences in the method of enumeration and to the readiness with which American enumerators accept without verification the claims of persons of questionable standing to be physicians. No doubt the quality, if not the relative number, of American physicians has improved within a generation and as a result their ability to diagnose cancer by clinical means, while still far from adequate, is probably greater than it was in 1880.

About the proportion of deaths in which the cause is certified by a physician, we have no satisfactory information for the United States or any part of it. But even if it has not increased during the last generation, the rise in the level of the profession—a change which occurred earlier in some European countries—has led to a similar result, for the incompetent physician is less likely than the well-trained one to certify cancer as a cause of death.

In several foreign countries, however, it is known that the proportion of deaths certified by physicians has increased of recent years In Saxony in 1873 only 37 per cent. but in 1906, 66 per cent. of the deaths were reported with a physician's statement giving the cause. In Bavaria the proportion of decedents whose deaths were medically certified rose from 45 per cent. for the years 1845–1850 to 65 per cent. for the years 1901–1902. In Würtemberg it rose from 47 per cent. for

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* Georg Radestock, "Zur Statistik der ärtzlichen Beglaubigung von Todesursachen," in *Zeitschrift des k. Sächsischen Statistischen Landesamtes,* LIV (1908), Pt. I, pp. 133–139.

1876–1881 to 63 per cent. for 1899–1900; in Baden, from 52 per cent. for 1852–1859 to 70 per cent. for 1892–1901. In Switzerland the statistics of causes of death are perhaps better organized than anywhere else. Dr. Prinzing awards it this preëminence among the European countries.* Particularly important for our purposes are the provisions in Switzerland whereby the attending physician makes a confidential report upon the cause of death to the statistical bureau and issues another certificate as a prerequisite to the burial. It may be more than a coincidence that the death rate from cancer in Switzerland is much higher than in any other country, but has not increased since 1900.† Both of these facts it would be easy to harmonize with the theory that the reported death rate from cancer depends largely upon the accuracy of certification and its increase upon the improvement of certification. The proportion of medically certified deaths in Switzerland increased from 82 per cent. in 1876–1880 to 96 per cent. in 1901–1903. In these 5 countries as a group, and they are the only ones for which I have found the information, the ratio of deaths medically certified to all deaths has increased about 0.5 per cent. yearly.

The probability that a physician was in attendance upon a decedent varies with the economic value of the endangered life and that depends not merely upon the wealth or position of the family but also upon the age of the individual Thus in Saxony in 1905 among children under 1 year of age less than 2 deaths in 5 were medically certified, but at ages 20–29 about 15 in 16 were so certified. With advancing age the proportion sank rapidly: at 50–59 it was 91 per cent.; at 60–69 it was 86 per cent.; at 70–79 it was 71 per cent.; and at ages above 80 it was 55 per cent.‡ Similar variations with age are found in the figures for Würtemberg.§

The death rate from cancer steadily increases with age until near the end of life.|| There is a large proportion of persons

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* *Op. cit.*, pp. 321 and 325.

† Appendix, Table XX, and *Hoffman*, p. 674.

‡ Radestock, *op. cit.*, p. 137.

§ Prinzing, *op. cit.*, p. 322.

|| The highest death rate almost always occurs at some age period above 70. See Appendix, Tables XII, XIII, XV, XVI, XVII, XVIII, and XIX.

dying at an advanced age without a physician's care. Probably this proportion is decreasing with the progress of the years, accompanying the decrease in the proportion at all ages already demonstrated and the improved economic position of the poor. These facts together furnish good ground for believing that a steady and important shift in the certification of deaths from an indefinite cause, like old age, to cancer has been in progress and that this has been closely dependent upon a change in the authority stating the cause of death at high ages, *i. e.*, from layman to physician. The deaths in Saxony in 1905 were classified according to the cause assigned and the proportion under each cause which received medical certification was stated. At the top of the list was cancer, a cause certified by physicians in 97 per cent. of the cases, and near the bottom of the list was old age, a cause certified by physicians in only 42 per cent. of the cases. Hence the spread of medical certification would necessarily result in the appearance under cancer of not a few deaths which, under earlier conditions, would have been certified by a layman as due to old age.

Influences contributing to the same result are the extension of hospital facilities and the increase in the proportion of autopsies. It is difficult to get figures about either. The importance of autopsy in diagnosing cancer is illustrated by Riechelmann's statement that in 1895–1901 a municipal hospital in Berlin had 711 cases of cancer established by autopsy, 156 of which, or 22 per cent., had not been so diagnosed during the lifetime of the patient, although the diagnosis had been made with the greatest care by the highest authorities, thus excluding the carelessness with which the ordinary physician in Berlin still reported the causes of deaths occurring in his practice.*

To be sure, not all the mistakes are on the same side. Sometimes a clinical diagnosis of cancer is negatived by the findings at the autopsy. But the additions resulting from autopsy exceed the subtractions. This is indicated by Dr. Bashford's evidence. In 1909 he reported upon 9,488 fatal cases in hospitals which had been treated during the life of the patient as cancer and after death had been checked by autopsies. This check showed that 757 cases, or 8.0 per cent., of those so diagnosed were not cancer. But during the same period and in the same hospitals, 1,801 other cases of fatal disease, more than twice as many, which during life had not been diagnosed as cancer were shown by autopsies to be so. The net result was to show that the true number of deaths from cancer in these hospitals was 10,532 instead of 9,488, so that the number diagnosed as cancer, rightly or wrongly, by clinical means during the lifetime of the patient was only 90 per cent. of the deaths actually due to this disease. In cases of cancer attacking accessible parts of the body the number of deaths determined by clinical examination was 98 per cent. of the true number; but where inaccessible parts of the body were primarily involved the number of deaths determined by clinical examination was only 68 per cent. of the true number.*

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* W. Riechelmann, "Eine Krebsstatistik vom pathologisch-anatomischen Standpunkt," in *Berliner Klinische Wochenschrift,* XXXIX (August 4, 1902), p. 729.

Dr. Williams has suggested that "these were specially selected lots of difficult hospital cases and cannot be regarded as in any way typical of every day experience."† That is a question upon which a layman must speak with diffidence, but in my opinion the greater attention and skill bestowed upon hospital patients would more than offset the greater difficulty of diagnosis, if it exists.

If physicians attending hospital patients often fail to diagnose cancer, such failures must be far more common among physicians in general practice, in which case an increase in the ratio of deaths in hospitals to all deaths would mean an increase in the ratio of deaths ascribed to cancer to all deaths from it. This suggests the question, Is the ratio of deaths in hospitals to all deaths increasing? The only evidence for the United States is indirect. At the end of 1904, to every 100,000 people there were 87 patients in American public hospitals; at the end of 1910 there were 118, an increase of more than one third in 6 years. During the year 1904, the number of patients treated in public hospitals was 1,309 per 100,000; during the year 1910, it was 2,124, an increase of nearly two thirds in 6 years.‡

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* *Lancet*, 1909, II (Sept. 4), p. 694.

† W. R. Williams, *The Natural History of Cancer*, p. 54.

‡ United States Census Bureau, *Benevolent Institutions, 1904*, p. 32; *Benevolent Institutions, 1910*, pp. 48–49.

In Greater New York the proportion of deaths in hospitals to total deaths has doubled in the 17 years since the enlarged city was organized, rising from 16.3 per cent. in 1898 to 32.9 per cent. in 1915. In old New York the same change was in progress through an earlier period, the proportion of deaths in hospitals to all deaths rising from 15.4 per cent. in 1889 to 22.0 per cent. in 1897.*

German figures giving the number of beds in general hospitals, public and private, indicate a change almost as rapid. In that Empire in 1877 there were 166 hospital beds to 100,000 people and in 1910 there were 400, nearly two and one half times the earlier ratio.†

The figures for Austria‡ point to a slower increase. Owing to differences in the classification of hospitals in the two countries, the following ratios are not comparable with those for Germany.

Year.	Hospital Beds per 100,000 Population.
1870	118
1880	124
1890	142
1900	179

In France the average annual number of beds in hospitals in the periods 1871–1880 and 1901–1905§ may be compared with the population in the middle of each period. The results show an increase in beds per 100,000 people from 193 to 236 in about 30 years. Probably a similar change is under way in nearly every civilized country and there is little doubt that it has materially increased the chance of correctly diagnosing cancer as a cause of death.

The preceding evidence shows that in every European country for which the information was available the proportion of physicians to population and the proportion of deaths certified by physicians have increased; that in the United

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* See Appendix, Tables XXI and XXII.

† See Appendix, Table XXIII.

‡ Prinzing, *op. cit.*, p. 545.

§ From *Stat. annuelle des Instit. d'Assistance* (1906), cited in Webb, *New Dict. of Statistics*, 1911, p. 298.

States, although neither is known to have risen, the average competence of physicians has probably increased; that in several European countries even now a large proportion of deaths at ages when cancer mortality is highest are not medically certified; that cancer is the cause of death least often stated by a layman; and that hospital facilities are more numerous and autopsies more frequent than ever before. With this evidence in mind, we are in a better position to weigh the arguments tending to show that improvements in the diagnosis and certification of cancer, which have long been in progress and are still continuing, explain at least in large part the increase in its reported mortality.

Let us assume for a moment the extremely skeptical position that the entire increase in the reported death rate, aside from that part due to increasing longevity, is due to improved diagnosis; or that the only influence affecting the death rate from cancer which has been statistically demonstrated is age. In other words, assume that there are no demonstrated differences in the true cancer death rate of men and women, of white and colored, of residents in city and country or in different countries, but that all differences in the recorded rates of these groups at the same age are due to differences in the accuracy of diagnosis. From this assumption certain corollaries would follow. If they are shown to conform to the facts, the assumption is thereby and to that degree made probable.

1. Is the proportion of deaths reported as due to an unknown or ill-defined cause decreasing? In the part of the United States for which significant figures exist, the registration states of 1900, the number of deaths ascribed to ill-defined or unknown causes* since 1900 has been steadily diminishing. In 1900 there were 13,116 deaths from this group of causes; in 1915 there were 1,090, a decrease of 12,026, or 91.7 per cent. But these deaths are distributed to the several ages of life in somewhat the same proportion as other causes of death, while cancer is characteristically a disease of adults and aged persons. Hence it is fairer to exclude all deaths ascribed to ill-

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* In general terms this group includes every death which was said to be due to ill-defined organic disease, sudden death, or a cause ill-defined or not specified.

defined or unknown causes in which the decedents were less than 30 years of age. In 1900 there were in these registration states 6,362 deaths of persons over 30 years of age which were ascribed to ill-defined or unknown causes; in 1915 there were only 520, or about one twelfth as many. As the population increased, while the deaths decreased, the death rate from such causes fell still faster, from 74.9 per 100,000 population over 30 years of age in 1900 to 4.5 per 100,000 in 1915, or one sixteenth of the earlier rate.

An estimate of the number transferred from ill-defined causes to all other causes may be reached in the following way. If the rate in 1915 had been the same as in 1900, the deaths above 30 years of age from unknown causes would have been 8,696. The difference between that number and 520, or 8,176, represents the number probably transferred from ill-defined and unknown causes to some specific cause. If we assume that these were transferred in a random way, or in the proportions which each of those causes bore to all causes except the ill-defined group, then 9.6 per cent. of the 8,176 transfers, or 784, went to cancer. The actual increase in the cancer death rate between 1900 and 1915 was from 144.3 to 202.3 per 100,000 population over 30 years of age, or 40.2 per cent. If these 784 estimated transfers were excluded, the increase would be only from 144.3 to 195.5, or 35.5 per cent. On these assumptions between one ninth and one eighth, 11.7 per cent., of the apparent increase was due to transfers from ill-defined causes to cancer. But in assigning causes of death the modern tendency is away from vague, indefinite causes to specific, definite causes. Hence, the gain by transfers to cancer has probably been greater than a mere chance distribution of the transferred cases would indicate. If so, more than one ninth of the increase in the cancer death rate of the registration states of 1900 between 1900 and 1915 was due to a certification of deaths in 1915 as due to cancer which, under conditions existing in 1900, would have been returned as due to ill-defined or unknown causes.

In dealing with this aspect of the question, if errors are to be avoided, the specific conditions surrounding certification and registration in each country must be known, and especially whether the residual class of ill-defined and unknown has retained the same meaning throughout. This knowledge I have found it difficult to acquire and for that reason I have made no study of such transfers in other countries.

But after this warning it may be pointed out that in England and Wales, according to *March*, the deaths ascribed to unknown causes fell from 45,273 in 1858 to 3,318 in 1910, a decrease of 93 per cent. However, in this case there is reason to suppose that the meaning of the term *unknown* has changed. In Scotland between 1855 and 1910 the deaths from unknown causes fell off by three fifths and, as the population increased, the death rate fell off by three fourths; in Ireland the death rate from unknown causes fell by one third between 1881 and 1910. In Prussia between 1875 and 1910 the deaths from unknown causes decreased from 101,633 to 18,434, or nearly five sixths and the rate about eight ninths; in Baden the decrease in deaths from unknown causes was from 1,381 in 1881 to 17 in 1910; in Italy from 22,977 in 1890 to 3,455 in 1910 and in the more populous divisions of Australia since 1891 similar changes have been in progress with great rapidity. All this evidence seems to warrant us in concluding that in many countries the assignment of deaths to cancer, which under earlier conditions would have been assigned to unknown or ill-defined causes, has played an important part in exaggerating the increase in reported cancer mortality.

2. Is the proportion of deaths reported as due to tumor decreasing? The reported death rate from tumor, or, more exactly, benign tumor, has been decreasing, while the death rate from cancer, sometimes called malignant tumor, has been increasing. These changes in opposite directions are probably to be ascribed in large part, if not entirely, to a more accurate discrimination between cancer and tumor, or a greater willingness among friends of the decedent to have the word *cancer* appear on the death certificate. As a result many deaths in recent years have appeared in the cancer column which under earlier conditions would have appeared as tumor. American evidence regarding this change goes back to a period

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* *March*, I, p. 829 and II, p. 235. But see the divergent figures for 1901 under this head in the two volumes.

long before 1900. In the census of 1880, this statement appears: "The reported number of deaths from cancer . . . is undoubtedly too small, if we use the term 'cancer' in the ordinary sense, for there is very little doubt that most of the deaths reported as due to tumor . . . might properly have been classed with cancer."* Ten years later the same authority said: "As it is impossible from the census data to distinguish the cases of tumor from those of cancer, they will be considered together."† The same treatment was accorded to them in 1900.‡ The diminishing proportion that deaths ascribed to tumor made of all ascribed to cancer and tumor combined is shown below.§

PER CENT. THAT DEATHS FROM TUMOR MAKE OF TOTAL FROM CANCER AND TUMOR.

Date.	Census Returns for all United States.
1880	12.0
1890	11.7
1900	10.4
	Returns for Expanding Registration Area of United States.
1900-1904	2.3
1905-1909	1.5
1910-1914	0.9

The first three lines refer to deaths from any part of the United States as returned by the enumerators outside, and by medical certification inside, of the registration area. The other three refer to the registration area alone, which embraced in 1900 two fifths and in 1914 two thirds of the population of the country.|| This expansion has carried registration into districts where the diagnosis of cancer is less trustworthy, probably, and hence the preceding figures obscure the results of improved diagnosis in an unchanging area. An idea of the exaggerated emphasis upon tumor as a cause of

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* U. S. Census Office, *Tenth Census*, XII, p. cxiv.

† U. S. Census Office, *Eleventh Census, Vital Statistics*, pt. I, p. 336.

‡ U. S. Census Office, *Twelfth Census*, III, p. clxxxi.

§ See Appendix Table XXIV, for fuller data.

|| U. S. Bureau of the Census, *Mortality Statistics, 1914*, p. 9.

death in the enumerators' returns alone may be derived from the complete data,* by subtraction. It appears that outside of the registration area of 1900, and thus in districts where the only source of information was enumerators' returns, 22 per cent. of the deaths from cancer and tumor were ascribed to tumor, but within the registration area at the same date only 2.9 per cent. of the deaths in that group were ascribed to tumor.

The evidence derived from the registration states of 1900 for the period 1900 to 1915 points to the same conclusion and is more weighty because the area covered by the figures did not change. In this case it is safe to speak of rates rather than of proportions. The results are as follows:

DEATH RATE PER 100,000 POPULATION IN REGISTRATION STATES OF 1900. (a)

Year.	Cancer.	Tumor.	Both.	Per Cent. of Deaths from Cancer.
1900	63.9	2.0	65.9	97.0
1901	65.8	1.6	67.4	97.6
1902	65.6	1.4	67.0	97.9
1903	69.0	1.7	70.7	97.6
1904	70.4	1.4	71.8	98.1
1905	72.4	1.4	73.8	98.1
1906	73.1	1.3	74.4	98.3
1907	75.7	1.2	76.9	98.5
1908	76.8	1.0	77.8	98.7
1909	79.4	1.0	80.4	98.8
1910	83.0	1.2	84.2	98.6
1911	83.9	0.8	84.7	99.1
1912	85.9	0.7	86.6	99.2
1913	88.7	0.5	89.2	99.4
1914	89.1	0.6	89.7	99.3
1915	91.8	0.5	92.3	99.4

(a) For the full table see Appendix, Table XXV.

In these 15 years the death rate from cancer has increased 27.9 per 100,000 population, but the death rate from tumor has fallen 1.5 per 100,000, so that the death rate from both combined has increased only 26.4 per 100,000. Thus the transfer from tumor to cancer seems to account for more than one twentieth of the total increase.

The influence of this progressive transfer of cases from tumor to cancer through a longer period is clearly revealed in the Massachusetts figures.† As the state classification differs from the federal and the latter is available only since 1900, I have relied throughout upon the former.

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* Appendix, Table XXIV.

† For the full table see Appendix, Table XXVI.

DEATH RATE PER 100,000 POPULATION IN MASSACHUSETTS.

Period.	Cancer.	Tumor.	Cancer and Tumor.	Per Cent. of Deaths from Cancer.
1853-1857	19.3	5.3	24.6	78.5
1858-1862	25.8	4.9	30.7	83.9
1863-1867	29.7	5.3	35.0	84.9
1868-1872	34.9	5.8	40.7	85.8
1873-1877	37.4	5.4	42.8	87.3
1878-1882	50.8	3.8	54.6	93.0
1883-1887	56.1	3.3	59.4	94.5
1888-1892	60.6	3.1	63.7	95.1
1893-1897	67.1	3.8	70.9	94.6
1898-1902	71.0	3.0	74.0	96.0
1903-1907	83.3	2.5	85.8	97.1
1908-1912	90.2	1.2	91.4	98.6
Increase or decrease (—) per 100,000	70.9	—4.1	66.8	

These figures indicate that about one seventeenth of the increase in the cancer death rate of Massachusetts was due to the certification of deaths at the close of the period as caused by cancer which under earlier conditions would have been ascribed to tumor.

The only article I have met with in which deaths from cancer and tumor are separately tabulated is one dealing with the statistics of Breslau for the period 1876–1899.* From its figures I have compiled the following:

Period.	Deaths from		Per Cent. from Tumor.
	Cancer and Tumor.	Tumor.	
1876-1879	666	94	14.1
1880-1884	969	67	6.9
1885-1889	1,291	69	5.4
1890-1894	2,024	204	10.1
1895-1899	2,729	307	11.3

A comparison of these figures with the others suggests that many of the deaths in Breslau ascribed to tumor are probably due to cancer and that there has been no steady improvement in discriminating between the two causes of death such as is indicated by the American figures.

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* F. Frief, "Die in den Jahren 1876–1900 in Breslau vorgekommenen Todesfälle an Krebs," in *Klinisches Jahrbuch*, XII (1904), pp. 133-200.

In England and Wales the Registrar-General in 1884 began the practice of sending an inquiry to every physician who reported a death without a satisfactory statement of its cause, and in 1887 extended this procedure to include every case of a death certified as due to tumor. In 1886 the deaths reported as due to cancer were 16,243, in 1911 they were 35,902, an increase of 18,659 in 25 years. But in 1911 there were 656 deaths which had been at first reported as due to tumor and which, after correspondence, were transferred to cancer. This number equals 3.5 per cent. of the increase. Probably a large, perhaps an equally large, number of cases in 1911 were returned in the first instance as cancer, although under the conditions of greater carelessness or ignorance prevalent before 1887 they would have been reported as tumor. This English evidence seems to corroborate the American by indicating that a significant part of the increase in the cancer death rate of recent years, a part which may be conservatively estimated as one twentieth, has been due to a transfer of cases from tumor to cancer.

3. Is the proportion of deaths reported as due to old age decreasing?

In the American registration states of 1900 the number of persons reported as dying of old age is steadily and rapidly decreasing. In 1900 it was 10,015 and in the same states in 1915 it was 4,380.* This change is not due to a decrease either in the total population or in those at high ages; for both the population and the proportion who die late in life to all deaths are growing. It is due rather to the unwillingness of many recording officials to receive vague statements of the cause of death and their efforts to secure on the death certificate a statement more specific and exact than "old age." Thus, in the *Manual of the International Classification of Causes of Death*, the *vade mecum* of American registration officers, the instruction under "old age" reads: "A very indefinite and unsatisfactory return as a cause of death. It is usually due to carelessness on the part of the physician and a more specific statement should be required." The decrease in the deaths ascribed to "old age" is due, then, to the increasing care with which returns are made and the closer supervision of them by the registration officials, and the change is a rough index of the improvement of registration. Doubtless many of the deaths which would formerly have been ascribed to "old age" now appear under cancer, contributing to swell the increase in the recorded, as distinguished from the actual, cancer death rate.

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* Appendix, Table XXVII.

To estimate the proportion of the increase in cancer mortality which can be thus explained, it is necessary to estimate first the number of deaths transferred from old age to all other causes and then the proportion and number which have gone to cancer. For this it is probably best to assume a constant ratio between the number of deaths ascribed to old age and the number of deaths of all persons above 60 years of age. In the registration states of 1900 this proportion in 1900 was 9.9 per cent. and in 1915 it was 3.2 per cent. If the per cent. had remained unchanged, 13,697 deaths would have been ascribed to old age in 1915; the number actually ascribed to it was 4,380. Hence it is probable that there were not far from 9,317 deaths in 1915 which under earlier conditions would have been ascribed to old age but which were ascribed to some other cause as a result of improvements in reporting causes of death. Of these 9,317 deaths, the number transferred to cancer may be estimated by assuming that the proportion was equal to that which the deaths above 60 years of age from cancer make of the deaths at that time of life from all causes except old age. This would indicate that 9.3 per cent. of the 9,317 deaths, or 866, were transferred from old age to cancer. If these 866 deaths be subtracted from the total ascribed to cancer in 1915, the increase in the cancer death rate during the 15 years 1900–1915 is reduced from 27.9 to 24.6 per 100,000. In other words, the transfer from old age to cancer serves to account for about 12 per cent. of the entire increase. But the tendency to change from old age to cancer must have been much greater than the tendency to change from old age to heart failure or general debility or some other meaningless term. If so, the transfers from old age to cancer in this instance must account for more than 12 per cent. of the increase in cancer mortality.

The difficulties which prevented an international study of the transfers from ill-defined and unknown causes to cancer do not equally hamper a study of the transfers from old age. I have found no reason to suppose that the heading *old age* or its counterpart in the international classification, *senile debility* or *senility*, has materially changed its meaning. The decreasing death rate from this cause is shown in the following table, giving the death rate from old age for every fifth year since the record began. The data are taken from *March.*

DEATH RATE PER 100,000 POPULATION FROM OLD AGE, OR SENILITY, VARIOUS EUROPEAN STATES.

Year	England and Wales.	Scotland.	Ireland.	Norway.	Switzerland.	Prussia.	Bavaria.	Baden.	Italy.
1855		191							
1860	143	215							
1865	136	183	173						
1870	128	192	295	38					
1875	119	169	405	49		264			
1880	100	129	432	48	112	251			
1885	103	123	381	45	125	247		197	
1890	98	116	401	44	130	248	245	215	101
1895	98	110	388	107	128	221	213	182	125
1900	99	103	364	175	170	236	209	173	148
1905	92	84	197	194	73	201	191	154	143
1910	88	74	208	187	55	167	161	146	140

The preceding figures show that in most of the countries the death rate from old age is now falling and that in several it has fallen without interruption from the first. Probably in all these countries the proportion of deaths at ages above 60, 70, or 80 to all deaths or to all persons living is increasing. Hence many deaths must be now ascribed to other causes which, under earlier conditions, would have been ascribed to old age, and no small proportion of these must have gone to cancer.

The preceding estimates explain away not less than three tenths of the increase in the reported mortality from cancer, namely, transfers from ill-defined or unknown causes to cancer perhaps 12 per cent., transfers from old age to cancer perhaps 12 per cent. and transfers from tumor to cancer perhaps

6 per cent. But the two larger figures have been reached by assuming that the transfers from indefinite to definite causes had a random distribution among the groups to which they went, while in fact the distribution tends to center on specific and precise causes. For this reason the results may fairly be deemed minimum figures and not a little below the truth. Accordingly, I conclude that from three tenths to one half of the increase in the death rate from cancer in the registration states of 1900 is due to the causes mentioned and is apparent rather than real.

If to these results we add the earlier conclusion that, on the average, not less than one tenth of the increase in cancer mortality is due to the increasing proportion of adult and elderly persons in the population, I conclude that not less than four tenths and perhaps as much as six tenths of the increase in cancer mortality has been explained as only apparent.

These are all the results of improved diagnosis and certification upon the recorded cancer mortality which I have found any means of measuring even roughly. There are other changes, however, which have already been mentioned and need examination, although their influence cannot be measured.

4. Is the mortality from cancer low where there are few physicians or where a small proportion of the death certificates are prepared by physicians and vice versa?

We have already (p. 725) touched upon the relation between the reported death rate from cancer and the proportion of deaths certified by laymen. But additional evidence on this point may now be presented. In Saxony, of all deaths certified as due to cancer the per cent. certified by laymen was 18 in 1876 and steadily decreased to 4 in 1903. Hence, where certificates from doctors are few, the cancer mortality is likely to be low. In this respect no country, perhaps, includes greater extremes than Austria; Vienna is one of the medical centers of the world; Bukowina and Galicia are most meagerly furnished with physicians. *Prinzing* gives for each of the 17 provinces of Austria in the five year period 1896–

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* Georg Radestock, "Die Krebsterblichkeit im Königreich Sachsen in den Jahren 1873-bis 1903," in *Zeitschrift des k. Sächsischen Statistischen Landesamtes*, LI, Pt. II, p. 263.

1900 the per cent. of deaths the causes of which were certified by physicians, and *Hoffman* gives the death rates from cancer, 1907–1911, in the same provinces.† As the two returns do not speak for the same period, I have sought for the per cent. of medically certified deaths in the later years. The source‡ gives the information only for 1907 and 1910. rom this material I have computed the per cents. in the third column of the following table:

Province.	Death Rate from Cancer per 100,000 Population 1907–1911.	Per Cent. of Deaths which were Medically Certified	
		1896–1900.	1907 and 1910.
Salzburg	140	99.0	99.9
Upper Austria	136	98.2	99.3
Vorarlberg	125	96.3	98.4
Lower Austria	120	99.7	99.9
Tyrol	110	93.0	94.2
Bohemia	104	99.1	99.7
Trieste	99	98.8	99.9
Moravia	97	94.4	95.8
Styria	96	79.9	83.7
Corinthia	83	72.4	77.5
Silesia	67	70.1	74.7
Carniola	49	35.0	35.9
Görz and Gradiska	46	43.1	47.1
Bukowina	46	32.8	33.7
Istria	43	44.7	51.0
Galicia	33	26.5	27.6
Dalmatia	24	29.1	30.5
All Austria	79	68.0	68.5

Among the many factors which influence the reported death rate from cancer in Austria, there is one, the proportion of deaths certified by physicians, so potent as largely and, where the differences are great, almost exclusively to determine the rate. Evidently the very low reported death rate from cancer in Dalmatia and Galicia is due to the few reports from physicians and not to the infrequent occurrence of cancer in those provinces. A comparison of the second and third columns in the table shows that the proportion of medically certified deaths in every province increased between the earlier and later dates. The increase in the Austrian death rate from cancer during the same period from 69 to 78 per 100,000 was doubtless connected with this spread of medical certification.

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* P. 326.

† P. 680.

‡ *Oesterreichische Statistik.* The figures were kindly furnished by the New York Public Library.

The following table has been compiled from one in *Hoffman* by arranging the countries of Europe in the order of the cancer death rate.

Country.	Period.	Death Rate from Cancer per 100,000 Population.
Denmark (cities)	1908–1912	142
Switzerland	1908–1912	124
Holland	1908–1912	106
Sweden (cities)	1907–1911	105
Scotland	1908–1912	103
England and Wales	1908–1912	98
Norway	1908–1912	97
German Empire	1908–1912	87
Ireland	1908–1912	81
Austria	1908–1912	80
France	1906–1910	76
Belgium	1908–1912	67
Italy	1908–1912	65
Rumania (cities)	1907–1911	62
Spain	1908–1912	52
Greece (cities)	1904–1908	52
Hungary	1908–1912	46
Portugal	1906–1910	22
Serbia	1905–1909	12

This suggests that in the countries of Europe the cancer death rates vary, as in the provinces of Austria they have been shown to do, in general agreement with the number and quality of the physicians, or the proportion of deaths which are medically certified. But I have found no figures showing the proportion of physicians to population or the proportion of medically certified deaths in these countries and therefore must content myself with raising the question without answering it.

5. Can any differences be traced between the amount or the increase of cancer mortality in city and country?

The cities of the United States having at least 25,000 inhabitants in 1900 had 232 physicians to every 100,000 people and the rest of the country had 153, or only two thirds as many. Probably the number of visits made by a physician annually is greater in cities than in the country and the quality of his training is better. The proportion of young adults with lives

P. 594.

economically of high value is also greater in cities, and not a few invalids migrate to cities to avail themselves of medical and hospital advantages. All these circumstances would lead one to look for a higher cancer death rate in cities, if the assumption were correct that a direct and important connection exists between the number and quality of the physicians in a community, and its reported death rate from cancer. On the other hand, in country districts the proportion of aged persons peculiarly liable to cancer is larger. If, notwithstanding this physical basis for a higher cancer death rate in the country, the cities actually have the higher reported rate, then the difference is doubtless due in considerable measure to the larger number and greater ability of city physicians, if we assume that there is no actual difference in the liability of the two populations at the same ages to die of the disease. Now, in the cities of the registration states of 1900 the death rate from cancer in 12 of the 16 years during the period 1900–1915 was greater than in the country districts, indicating that in the United States there may be a connection between the proportion of physicians to population and the reported death rate from cancer.*

Between 1900 and 1915 the death rate from cancer in the cities of the registration states increased from 66.0 to 91.3 per 100,000, or 38.0 per cent. Meanwhile the country rate increased from 61.4 to 92.8, or 51.0 per cent., a more rapid increase in the country rate. During the same period we may be sure from evidence already given that hospital facilities and their use increased quite out of proportion to population. Hence there can be little doubt that deaths from cancer occurring in a hospital are now a larger proportion of all such deaths than formerly they were. And it is almost as certain that the current of cancer patients from country districts to city hospitals is increasing. If so, and if there are no other real differences between the cancer mortality of city and country districts than those due to differences in the proportion of elderly persons, the more rapid increase of the reported death rate from cancer in the country shows that some change, perhaps improved diagnosis and certification, has progressed so much more rapidly in the country as to overbalance the growing drift of cancer patients from country to city.

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* Appendix, Table XXVIII.

The tables in the international publications already mentioned facilitate a comparison between cities and country districts in certain European countries. Thus for England the population and deaths from cancer since 1880 are given for Birmingham, Bradford, Derby, London, and Liverpool by *Falkenburg*, and for the whole country by *Hoffman.* By subtracting the urban totals from those for all England a rough division between city and country is reached. In the same way the rates for Edinburgh and Glasgow combined may be compared with those for the rest of Scotland, those for Christiania with those for the rest of Norway, those for Amsterdam, the Hague, Rotterdam, and Utrecht with those for the rest of the Netherlands, and those for Vienna and Prague with those for the rest of Austria.* The computation shows that in sixteen out of twenty cases the crude urban rate was higher than that in the rest of the country and that in every country but England the increase in rate between 1881 and 1909, or in the case of Austria 1881 and 1908, was more rapid in the country districts, thus indicating that in Europe the difference between city and country has been decreasing. The figures for Austria are especially noteworthy. In 1881 the death rate from cancer in Vienna and Prague was 119.0, in 1908 it was 133.0. In the rest of Austria the rate in 1881 was 38.6, in 1908 it was 75.0. While the urban rate was increasing 12 per cent., the rural rate increased 94 per cent. In view of the other evidence which has been presented regarding conditions in the various provinces of Austria, it seems probable that nearly all of this increase in cancer mortality outside of the two capitals is due to improved diagnosis and certification.

Apparently, then, cancer mortality in cities, or at least in great cities, is usually higher but increasing more slowly than it is in country districts, so that in this regard the difference between city and country is decreasing. This is especially true wherever the initial differences between city and country are very wide.

6. Is the death rate from cancer among Negroes less than it is among whites?

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* For detailed figures, see Appendix, Table XXIX.

The greater longevity of the whites would result in a higher cancer death rate among all whites, even if there were no difference in the death rates of persons of the same age belonging to the two races. If the true cancer death rates of the two races at the same age periods are the same but medical attendance and certification are poorer among Negroes, then the reported Negro death rate from cancer would be the lower. Unfortunately the death rates by race are available for only 6 years, 1910–1915. They speak for the registration states of 1910 and embrace an annual average of over 39,000 deaths from cancer of whites and 900 deaths of colored, nearly all of them Negroes. The results are as follows:

Date.	Death Rates from Cancer per 100,000 Population Classified by Race in Registration States of 1910.		Per Cent. that Death Rate among Colored is of that Among White=100.
	White.	Colored.	
1910	76.8	52.6	68.4
1911	77.0	59.3	77.0
1912	79.8	59.3	74.3
1913	82.6	64.0	77.5
1914	83.5	65.4	78.3
1915	85.4	68.8	80.6
Per Cent. increase.	11.2	30.8	

The reported death rate of colored from cancer is from two thirds to four fifths that of the white, but is increasing faster, so that the difference between the races is diminishing. In view of the short period, the small number of Negro deaths involved and the erratic figures, no great weight can be given to the results.

I have obtained similar figures for the registration states of 1900, a much smaller area, in the same years. They have one advantage—they can be safely compared with figures for 1900.

For figures in full see Appendix, Table XXX.

The figures for 1900 refer to the census year rather than to the calendar year and the area embraced differs from that of the registration states of 1900 by excluding Indiana. But these differences do not materially affect the significance of the comparison here made.

Date.	Death Rates from Cancer per 100,000 Population Classified by Race in Registration States of 1900.		Per Cent. that Death Rate among Colored is of that Among White=100.
	White.	Colored.	
1900	62.5	41.3	66.1
1910	83.4	60.5	72.5
1911	84.1	74.2	88.5
1912	86.2	71.5	83.0
1913	89.0	70.8	79.6
1914	89.4	72.1	80.6
1915	92.1	79.4	86.2
Per Cent. increase.	47.4	92.2	

Here again it appears that the death rate from cancer among the colored is lower but increasing faster than that among the white. The changes from year to year are irregular. A comparison of the two tables shows that the death rate from cancer is uniformly greater for each race in the smaller region from which the states recently added to the registration area are excluded, as in the second table, a fact agreeing well with the theory that differences in the cancer death rates are due largely to the efficiency of the registration system, which even under the best of fostering care must be a plant of slow growth.

Mr. Hoffman's tables* show that in 8 large Southern cities between 1891 and 1914, the first and last years covered, cancer mortality among whites increased by 73 per cent. and that among Negroes by 92 per cent. He has long given special attention to the statistics of Negroes in the United States and notes that prior to the Civil War cancer among them was rare, that the present difference between the two races is less pronounced, but that the cancer mortality of Negroes is still materially below that of whites. These conclusions by one who accepts the opinion of qualified medical observers that "cancer is exceptionally rare among primitive peoples," are equally consistent with my own belief that much, if not all, of the difference is due to differences in the accuracy of diagnosis.

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* *Op. cit.*, p. 474.

† *Ibid.*, p. 15.

‡ *Ibid.*, p. 147.

7. Has the death rate from cancer increased more rapidly at the higher age periods than earlier in life?

The Census Bureau has kindly furnished me with a table showing the cancer mortality in the registration states of 1900 classified by age and sex for the two years 1900 and 1910. From these figures the following percentages of increase have been computed.

PER CENT. INCREASE IN THE DEATH RATE FROM CANCER BY SEX AND AGE IN THE REGISTRATION STATES OF 1900 FOR THE PERIOD 1900-1910.

Age.	Per Cent. Increase.	
	Males.	Females.
25-34	4	16
35-44	17	13
45-54	28	17
55-64	44	24
65-74	31	33
75+	34	42

The figures are not perfectly regular and yet they do show clearly that in each sex the increase at the higher ages is more rapid than that at the lower ages.

Similar evidence extending over a longer period of time is furnished by the Massachusetts records. The rates for a single year, when classified by sex and age, are often based on too few cases to be entirely trustworthy. The records cover the 6 census years 1860–1910, which, with due consideration of the sex differences, gives 10 cases.[†] In one of the 10 the most rapid increase was at ages over 80; in 3 it was at 70–79, in 3 it was at 60–69, and in only 3 was it at any period below 60, all 3 being at 30–39. This supports the previous conclusion that the increase of cancer mortality is greatest toward the end of a normal lifetime.

Similar rates for a series of decades are to be found in the successive decennial supplements to the *Reports of the Registrar General* and for 1901–1910 in his *Seventy-third Annual Report* for 1910. From them the following percentages of increase have been derived. As each rate speaks for a 10

[*] Appendix, Table XXXI.

[†] Appendix, Table XXXII.

year period and for a large population, the results are more regular and more significant than those previously reached.

PER CENT. OF DECENNIAL INCREASE IN THE DEATH RATE FROM CANCER BY SEX AND AGE IN ENGLAND AND WALES.

Age.	Per Cent. of Decennial Increase.			
	1861–1870. to 1871–1880.	1871–1880 to 1881–1890.	1881–1890 to 1891–1900.	1891–1900 to 1901–1910.
		Males.		
25–34	18	14	26	?
35–44	17	25	29	13
45–54	32	42	30	25
55–64	33	45	38	28
65–74	74	44	42	34
75+	32	31	49	?
		Females.		
25–34	9	0	2	?
35–44	18	8	5	−1
45–54	16	16	14	5
55–64	20	22	22	11
65–74	26	28	29	22
75+	26	31	39	?

The preceding figures all show that the increase in cancer mortality is greater at the higher ages. Incidentally the last series shows also that the increase of cancer among men is more rapid than that among women and that during the last decades observed there was a slight fall in the cancer mortality of English women between 35 and 45 years of age.

This more rapid increase at the higher ages is quite probably connected with improved diagnosis and certification. Ignorant or careless certification is likely to affect more seriously deaths not only of the weaker economic classes, like the Negroes, but also of the less economically valuable age periods, like those near the end of a normal lifetime. Hence an improvement in cancer diagnosis and certification would affect especially the increase in the reported death rate at later ages.

8. Is the increase in mortality from such forms of cancer as are difficult to diagnose more rapid than the increase in the forms easy to diagnose

The classification of deaths from cancer made by Messrs. King and Newsholme into accessible and inaccessible cases suffers from one questionable assumption. It tacitly assumes that such a dual classification is possible. In fact cases of cancer fall into a series with those easy of diagnosis at one end and those very difficult of diagnosis at the other. One important element, perhaps the most important element, in determining the position of any specific case on that scale is the part of the body involved. A recent bulletin of the federal Census Bureau* affords an objective test of this element by indicating what proportion of cases of each location were diagnosed by the reporting physician with reasonable certainty. It furnishes what students of the statistics of cancer have lacked hitherto, an objective basis for classifying deaths from this cause according to the certainty of the diagnosis and the part of the body first attacked. This classification has been derived from the physicians who reported 52,420 deaths from this disease in 1914. Their statements showing whether the diagnosis in each case rested on clinical evidence alone or had been confirmed by operation or autopsy enabled the Washington office to divide these 52,420 deaths into those in which the diagnosis was reasonably certain and those in which it was uncertain. From these figures the following results have been derived:

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* *Mortality from Cancer and other Malignant Tumors in the Registration Area of the United States, 1914.*